AbsTex & Sound absorption in free hanging textiles

- a brief description

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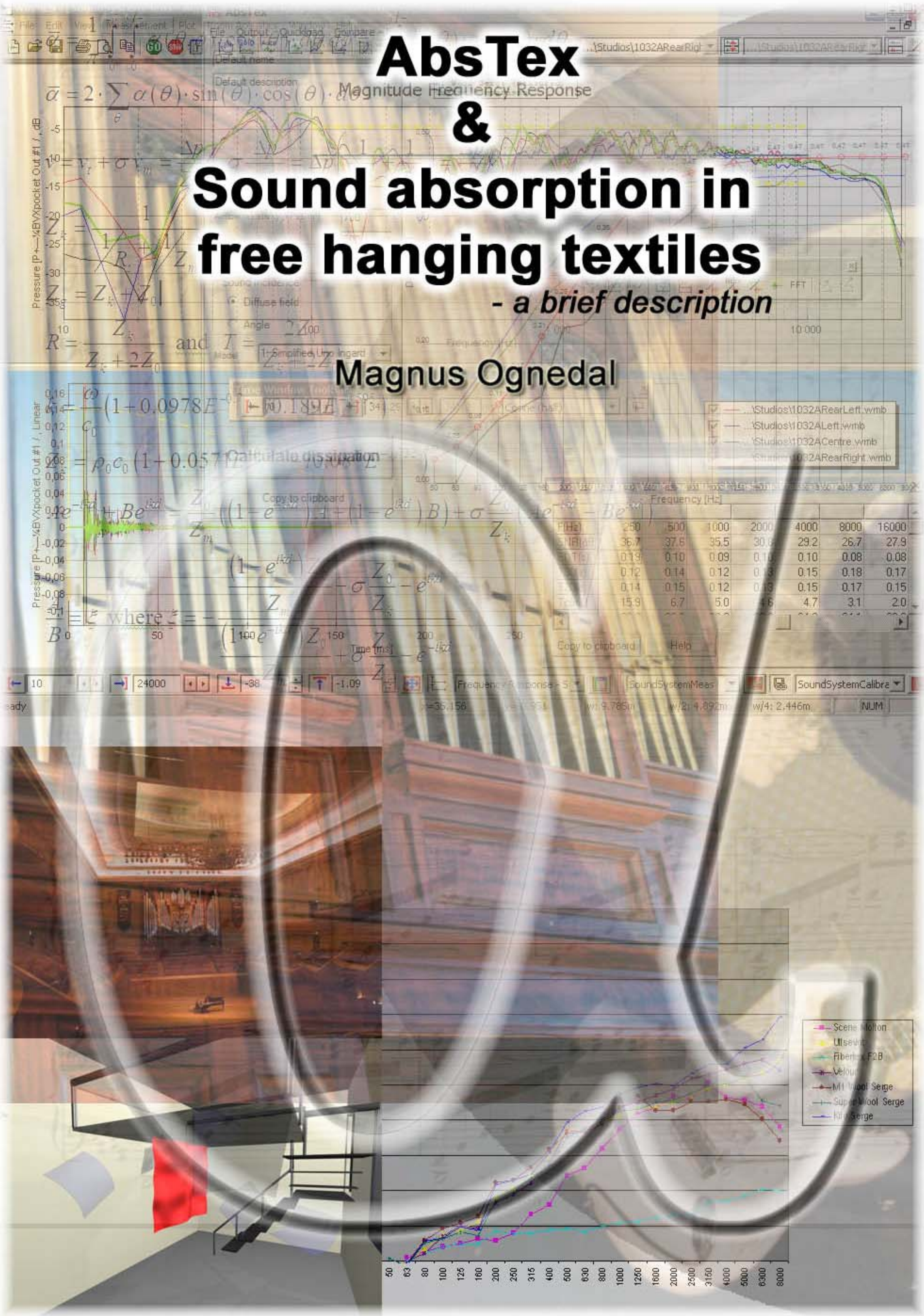

Summary

Hanging banners are used in many concert halls, theatres and multipurpose halls to adjust the reverberation times. A banner will absorb more sound energy when it is freely hanged compared to banners hanged at a distance to a wall. The database of absorption coefficients for freely hanged banners is limited.

Therefore three models for free hanging banners have been derived. The first model is based on a purely resistive layer. The second and third models are based on porous models, the model by Lord Rayleigh and the Delany-Bazley model respectively. These three models are combined with the vibration of the textile itself. The vibration of the textile is found by the principle that the difference in sound pressure between the two sides of a free hanging textile will cause the textile to vibrate slightly. This effect will cause the models to be mass-dependent.

The first model has an advantage: It is fairly easy to calculate and it is only based on the airflow resistivity and thickness (practically the specific airflow resistance) in combination with the mass. It also has no recommended upper limit in airflow resistance as the Delany-Bazley model has.

The models are named the Moveable Free-hanging Textile model (MFT), the Modified Rayleigh model (MR) and the Modified Delany-Bazley model (MDB). The MFT model seems to fit the measured values best. A rough estimation of the edge effect has also been developed.

Contents

Figures

1 Measured parameters for the textiles

The absorption coefficients were measured in a reverberation chamber with the textiles free hanging, 100 mm from a wall and in a standing wave tube. The transmission coefficients were also measured.

1.1 The measured textiles

Table 1 show the textiles used in this master thesis, together with the weight given by the manufacturers and a brief description of typical use of them in acoustical applications. (Please note that the weights given by the manufacturers may differ from what measured weights, see Table 3)

Table 1: The measured textiles.

	Textile	Weight [g/m^2]	Description
1.	Scene Molton	300	A typical inexpensive scene textile.
2.	Ullseviot	500	A tighter textile. Used as variable absorber.
3.	Fibertex F2B	140	Strong textile used as cover for mineral wool in e.g. slatted panels.
4.	Velour	530	Strong, fine textile. Used as scene curtain.
5.	M1 Wool Serge	650	Used as variable absorber.
6.	Super Wool Serge	500	Used as variable absorber.
7.	Kilo Serge	1000	Used as variable absorber.

1.2 Measured absorption and transmission coefficients

The seven textiles were measured in the reverberation chamber at NTNU. When measuring the absorption coefficients the textiles were hanged freely in the middle of the reverberation chamber. When measuring the transmission coefficient the textiles were mounted in a window-opening between the reverberation chamber and the adjacent room, “Lydrom 4” (see [1]).

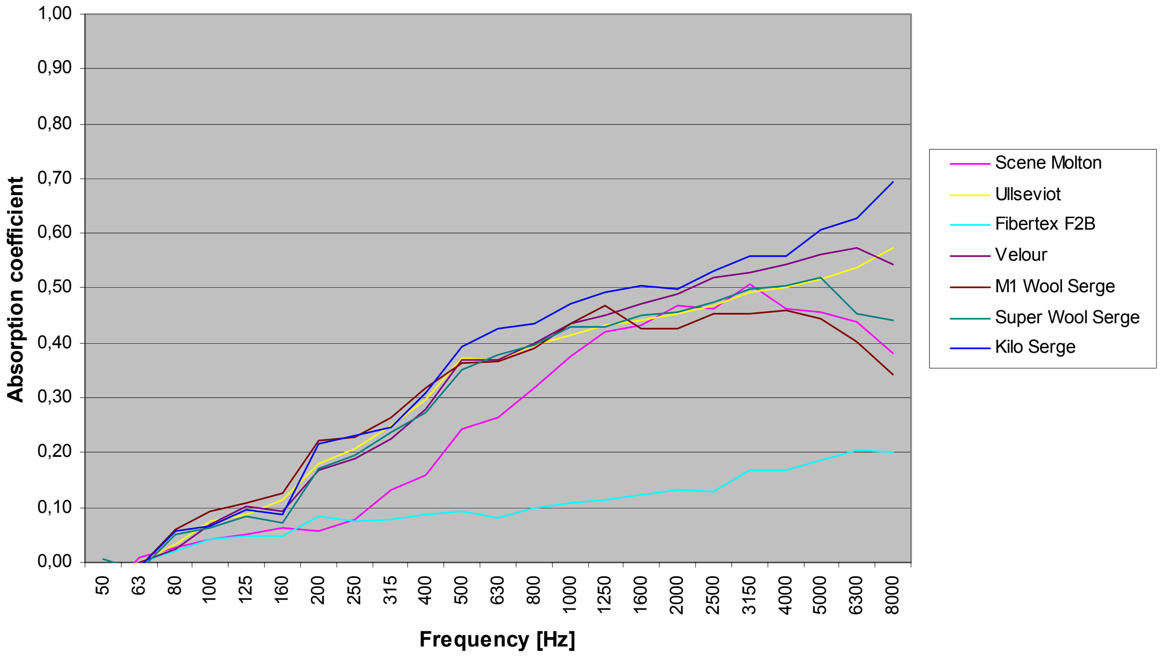

Figure 1: Measured one-sided absorption coefficients for all seven textiles, freely hanged. Measurements performed in the reverberation chamber at NTNU.

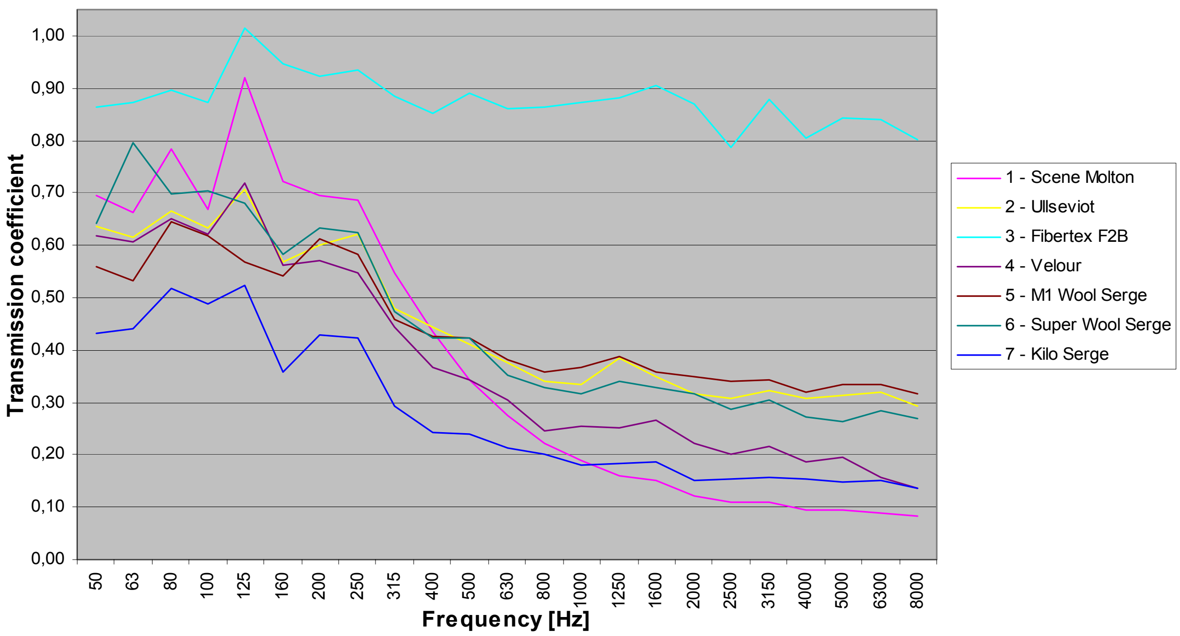

Figure 2: Measured transmission coefficients for all seven textiles. Measurements performed in the reverberation chamber and “Lydrom 4” at NTNU.

1.3 Airflow resistivities, dimensions and weights

Measured widths, lengths and areas are presented in Table 2. The airflow resistivity, weight and thickness for all banners were measured, see Table 3.

Table 2: Lengths, heights and areas of the textiles.

	Textile	Height **[m]**	Length **[m]**	Area **[m²]**
1.	Scene Molton	0.80	1.95	1.56
2.	Ullseviot	1.52	2.20	3.34
3.	Fibertex F2B	1.16	2.10	2.44
4.	Velour	1.47	2.16	3.18
5.	M1 Wool Serge	1.10	1.53	1.68
6.	Super Wool Serge	1.13	1.52	1.72
7.	Kilo Serge	1.14	1.50	1.71

Table 3: Measured airflow resistivities, weights and thicknesses.

	Textile	Airflow resistivity $\left[\frac{kPa \cdot s}{m^2}\right]$	Weight **[g/m²]**	Thickness $[mm]$
1.	Scene Molton	2994	363.2	0.99
2.	Ullseviot	647	477.5	1.41
3.	Fibertex F2B	35	192.2	1.20
4.	Velour Banner	668	545.4	2.30
5.	M1 Wool Serge	515	548.1	1.43
6.	Super Wool Serge	708	482.0	1.42
7.	Kilo Serge	807	886.2	2.56

2 Models for free hanging textiles

The models presented here are based on a purely resistive layer, the Rayleigh model and the Delany-Bazley model, and the assumption that the difference in sound pressure between the two sides of the textile will cause the textile to vibrate slightly.

The following models are based on the combination of the velocity of the banner and the particle velocity through a porous material. Since these velocities are directly linked to the difference in sound pressure between the two sides, the dissipation is too.

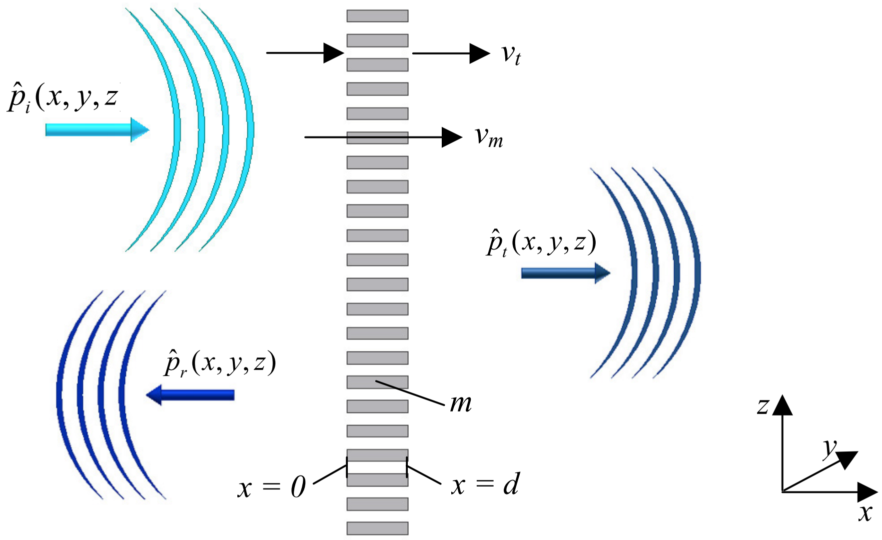

Figure 3: The basis for a free hanging porous textile.
Illustration of the sound pressure, mass, textile velocity and particle velocity.

Figure 3 show a sketch of the problem which may be described by the incoming sound pressure wave p_i(x,y,z), the reflected and transmitted sound pressure wave, the velocity of the banner, v_t, and air particle velocity within the banner, v_m.

2.1 The Moveable Free-hanging Textile model

If we assume that the banner is infinitely thin and the particle velocity is constant through the banner, we can write:

$$p_1 - p_2 = v_m \cdot \sigma R_S \tag{2.1-1}$$

where R_S is the specific airflow resistance which can be relatively easily found (it's the product of the specific airflow resistance r and the thickness d), σ is the porosity and v_m is the particle velocity. This can be solved for v_m:

$$v_m = \frac{p_1 - p_2}{\sigma R_S} = \frac{\Delta p}{\sigma R_S} \tag{2.1-2}$$

The total particle velocity, v, may then be written as

$$v = v_t + \sigma v_m \tag{2.1-3}$$

From the connection between sound pressure and velocity we get an expression for the specific acoustic impedance for the model.

$$v = v_t + \sigma v_m = \frac{\Delta p}{Z_m} + \sigma \frac{\Delta p}{\sigma R_s} = \Delta p \left(\frac{1}{Z_m} + \frac{1}{R_s} \right) = \frac{\Delta p}{Z_k}$$

$$\Rightarrow \quad Z_k = \frac{1}{1/R_s + 1/Z_m} \qquad \textbf{(2.1-4)}$$

This may be interpreted as a parallel connection between the limp mass impedance and the specific airflow resistance.

We can rewrite the equations to

$$Z_g = Z_k + Z_0$$

$$\Rightarrow \quad R = \frac{Z_k}{Z_k + 2Z_0} \quad \text{and} \quad T = \frac{2Z_0}{Z_k + 2Z_0} \qquad \textbf{(2.1-5)}$$

The dissipation (or absorption if you prefer) may then be found with $\rho = 1 - |R|^2 - |T|^2$. The model is named *Moveable Free-hanging Textile* (or MFT for short).

After finding these expressions it was brought to my attention that this is almost the same to what Uno Ingard [3] has derived, although with a slightly variation. Ingard also uses parallel connection between the limp mass impedance and the airflow resistivity, but adds the "reactance" of the textile in form of $i\omega d v_m$. This gives little lower dissipation coefficients for higher frequencies, but for a textile with thicknesses as used here, this has no practical effect.

This model predicts a maximum in dissipation coefficient of 0.5 for $R_S = 2\rho_0 c_0$ for normal incidences. Values lower and higher than this value will, according to the model, result in a lower dissipation.

2.2 Modifications of the porous models by Rayleigh and Delany-Bazley

We are searching for a general principle for free hanging textiles that can be used for more than one porous model. This can be achieved by defining the sound pressure and particle velocity as:

$$p(x) = Ae^{-ikx} + Be^{ikx}$$

$$v_m(x) = \frac{1}{Z_k}\left(Ae^{-ikx} - Be^{ikx} \right) \qquad \textbf{(2.2-1)}$$

where *A* and *B* are pressure amplitudes for the incoming and outgoing sound waves.

At the borders $x = 0$ and $x = d$ (where *d* is the thickness of the banner, see Figure 3) we get

$$\begin{aligned} & p_1 = p(0) = A + B \\ & p_2 = p(d) = Ae^{-ikd} + Be^{ikd} \\ \text{and} \quad & \Delta p = p_1 - p_2 = \left(1 - e^{-ikd}\right)A + \left(1 - e^{ikd}\right)B \end{aligned} \qquad \textbf{(2.2-2)}$$

and the particle velocity

$$\begin{aligned} v_{m,1} &= v_m(0) = \frac{1}{Z_k}(A - B) \\ v_{m,2} &= v_m(d) = \frac{1}{Z_k}\left(Ae^{-ikd} - Be^{ikd}\right) \end{aligned} \qquad \textbf{(2.2-3)}$$

The total velocity on each side of the banner can then be written as

$$\begin{aligned} v_1 &= v_t + \sigma v_{m,1} \\ v_2 &= v_t + \sigma v_{m,2} \end{aligned} \qquad \textbf{(2.2-4)}$$

At the right side of the banner ($x = d$) we know that $Z_0 = p_2/v_2$ which gives us

$$\begin{aligned} & Ae^{-ikd} + Be^{ikd} = \frac{Z_0}{Z_m}\left(\left(1 - e^{-ikd}\right)A + \left(1 - e^{ikd}\right)B\right) + \sigma\frac{Z_0}{Z_k}\left(Ae^{-ikd} - Be^{ikd}\right) \\ \Rightarrow \quad & \frac{A}{B} = \xi \\ \text{where} \quad & \xi = -\frac{\dfrac{\left(1 - e^{ikd}\right)Z_0}{Z_m} - \sigma\dfrac{Z_0}{Z_k} - e^{ikd}}{\dfrac{\left(1 - e^{-ikd}\right)Z_0}{Z_m} + \sigma\dfrac{Z_0}{Z_k} - e^{-ikd}} \end{aligned} \qquad \textbf{(2.2-5)}$$

At the left side of the banner ($x = 0$) we can find the input impedance:

$$\begin{aligned} & Z_g = \frac{A + B}{\dfrac{\left(1 - e^{-ikd}\right)A + \left(1 - e^{ikd}\right)B}{Z_m} + \dfrac{\sigma}{Z_k}(A - B)} \\ \Rightarrow \quad & Z_g = \frac{\xi + 1}{\dfrac{\left(1 - e^{-ikd}\right)\xi}{Z_m} + \dfrac{\left(1 - e^{ikd}\right)}{Z_m} + \dfrac{(\xi - 1)\sigma}{Z_k}} \end{aligned} \qquad \textbf{(2.2-6)}$$

which can be used to find the reflection coefficient R.

We may then express the transmission as:

$$T = \frac{p_2\left(1+R\right)}{p_1} = \frac{\xi e^{-ikd} + e^{ikd}}{\xi + 1}\left(1+R\right) \tag{2.2-7}$$

and we may find the dissipation coefficient with $\rho = 1 - |R|^2 - |T|^2$. These expressions can then be used with the Rayleigh and Delany-Bazley models which give complex wave numbers and impedances based on the given airflow resistivity (*r*) , the porosity (*σ*) and the thickness (*d*).

2.3 Results and discussion

The three developed models have been tested with parameters for the seven measured textiles. The effect of the velocity of the textile has been tested. A proposal for calculating the edge effect for low frequencies is also presented.

2.3.1 Results from the models for free hanging textiles

The new models have been tested with measured airflow resistivities, densities, thicknesses and calculated porosities. The results are compared to measurements of the textile samples from a reverberation chamber. All calculations were done in AbsTex.

All three models give better results as compared to earlier test done with the Mechel model [1] [2]. It may be assumed that the reason for this is that the new models also take the vibration of the textile into account.

For the banners most alike (Ullseviot, Velour, M1 Wool Serge and Super Wool Serge), we see that the measured absorption coefficients are somewhere between the Modified Rayleigh model (from now “MR”) and the Modified Delany-Bazley model (from now “MDB”) for frequencies up to 1 kHz, see Figure 4. For frequencies lower than 1 kHz the MFT model is always higher for these banners.

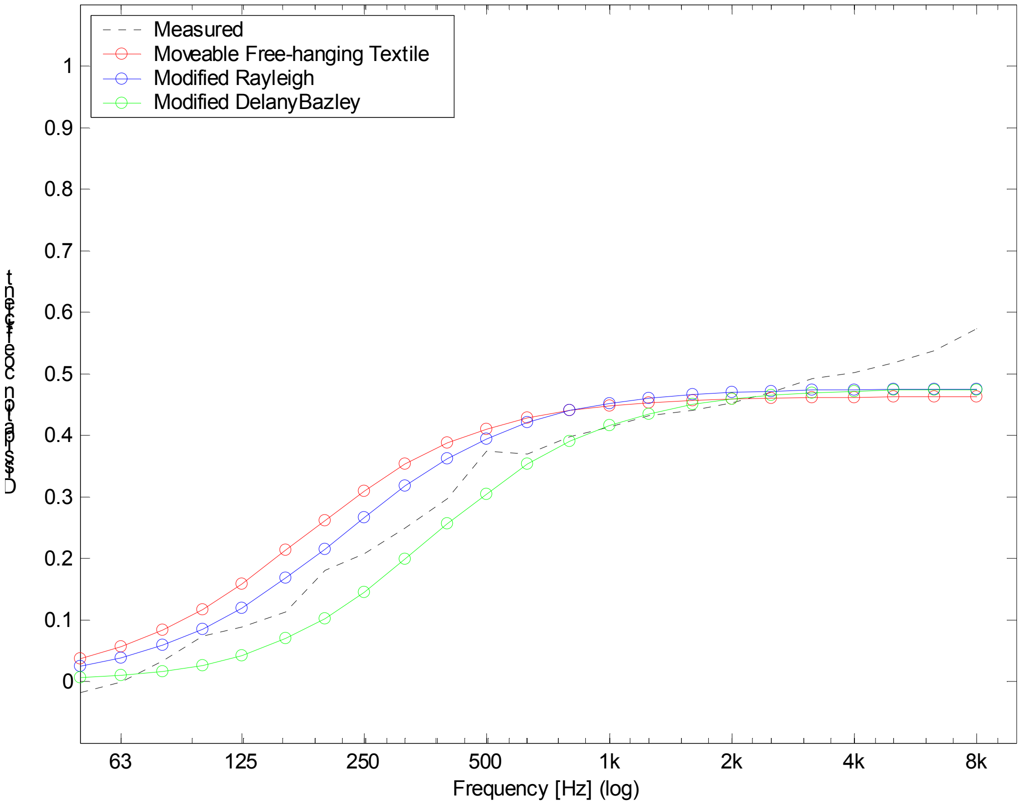

Figure 4: Results for Ullseviot for all three models in diffuse field.
r = 647 kPa·s/m^2, m = 477.5 g/m^2, d = 1.41 mm and σ = 0.656.

2.3.2 Differences between the MFT model and Ingards Volume absorber

As earlier mentioned, the main difference between the MFT model and Ingards Volume absorber is that Ingard has added the "reactance" of the textile in form of $i\omega d v_m$. This "addition" actually makes the dissipation coefficient lower, especially for higher frequencies.

For a "typical" textile (with r = 700 kPa·s/m^2, m = 600 g/m^2 and d = 1.50 mm) the maximum difference between the two models occurs at 8 kHz and is approx 0.35% which is so little that it may be neglected, see Figure 5.

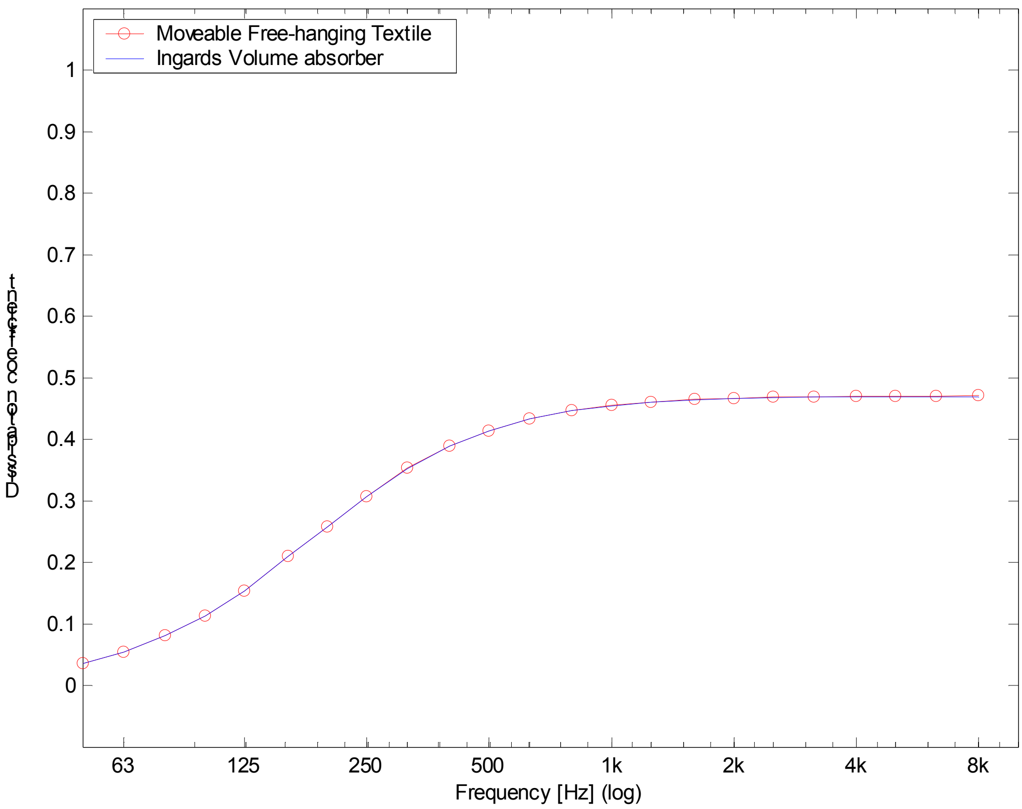

Figure 5: Comparison for the MFT model and Ingards Volume absorber. Calculated with r = 700 kPa·s/m^2, m = 600 g/m^2 and d = 1.50 mm.

2.3.3 A rough estimation of the edge-effect

There is a need for a practical method to incorporate the edge effect. How much will the low frequency absorption or dissipation change with the size of the banner? We know qualitatively that the loss coefficients will tend to be larger the smaller the sample size. At the same time will a smaller sample interact less with the sound wave of the same wave length, at least when freely suspended. Practical tests using WinFLAG also indicate that the edge effect depend on the thickness of the sample.

However, with the MFT model the textile is regarded as infinitely thin. The dependency of mass may act as a kind of "high pass filter" for the dissipation coefficient as seen in Figure 6. If the mass is increased the model returns more dissipation and lower mass give less dissipation. This is because the textile velocity, v_t, and the limp mass impedance has a inverse linear relationship.

If the diffraction around the sample is taken into account, some effect of the dissipation is lost due to "short circuiting" of the sound wave. For lower frequencies it may be assumed that the sound pressure behind the sample is reduced while the airflow resistivity and the velocities for the banner stay the same. This may be interpreted as one option: To reduce influence of the mass. For free hanging textiles with larger dimensions than the textiles measured here, the effect of diffraction will be reduced and we may expect to find an increased low frequency dissipation. If the textile has smaller dimensions than the measured textile, the effect of diffraction will be more significant.

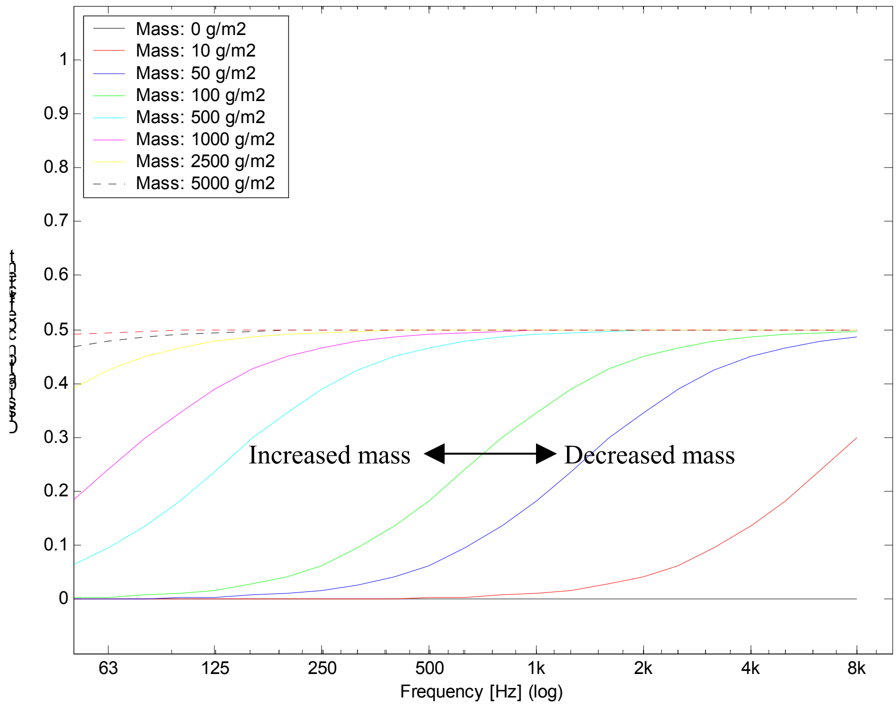

Figure 6: Dissipation coefficient for a textile with $R_S = 2\rho_0 c_0$ and different masses. Calculated for normal incidence using the MFT-model.

If the weight of the banner is greater than ca. 400 g/m^2, trial and error have lead to the suggestion that the dissipation coefficient for frequencies lower than ca. 900 Hz fits better to the measured data if the mass for the textile is reduced by ⅓ (for diffuse field calculations).

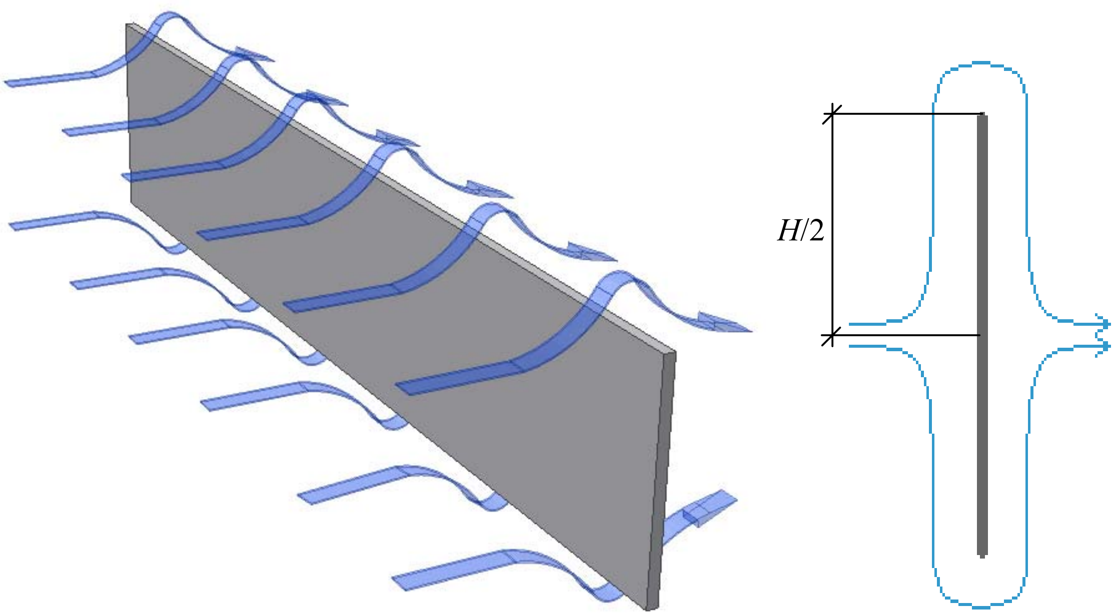

Figure 7: Simplification of wave around an oblong textile in 3D (left) and 2D (right). Blue indicates the sound sound wave.

However, if we assume that this correction of mass is dependent of the difference in phase between the incoming and the diffracted wave, the correcting of the mass has to be frequency-dependent. For example, it may be assumed that if the difference in phase is 10%, the mass should be reduced by 90%. It may also be assumed that the waves will diffract around the shortest dimension because this is the “easiest way” around the banner. The banner is assumed to be in the form of a rectangle with an area of $H \cdot L$ where H is the shortest edge and L is the longest edge.

From Figure 7 it can be seen that the diffracted sound wave has gone H longer than an incoming wave, so the difference between the incoming and diffracted sound wave can be written as:

$$C_m = \frac{\lambda}{\lambda + K_1 H} \quad \textbf{(2.3-1)}$$

where λ is the wavelength ($\lambda = c_0 / f$) of the sound wave in m, and K_1 is found in an iteration operation. This expression seems to fit best the measured values when $K_1 = 8$.

The mass used for calculation may therefore be written as:

$$m' = m \cdot (1 - C_M) \quad \textbf{(2.3-2)}$$

where m is the original mass.

In Figure 8 this effect is calculated for the Velour textile. It may seem like this correction has little impact on the overall performance, but for other textiles with different masses and dimensions, the results may be different.

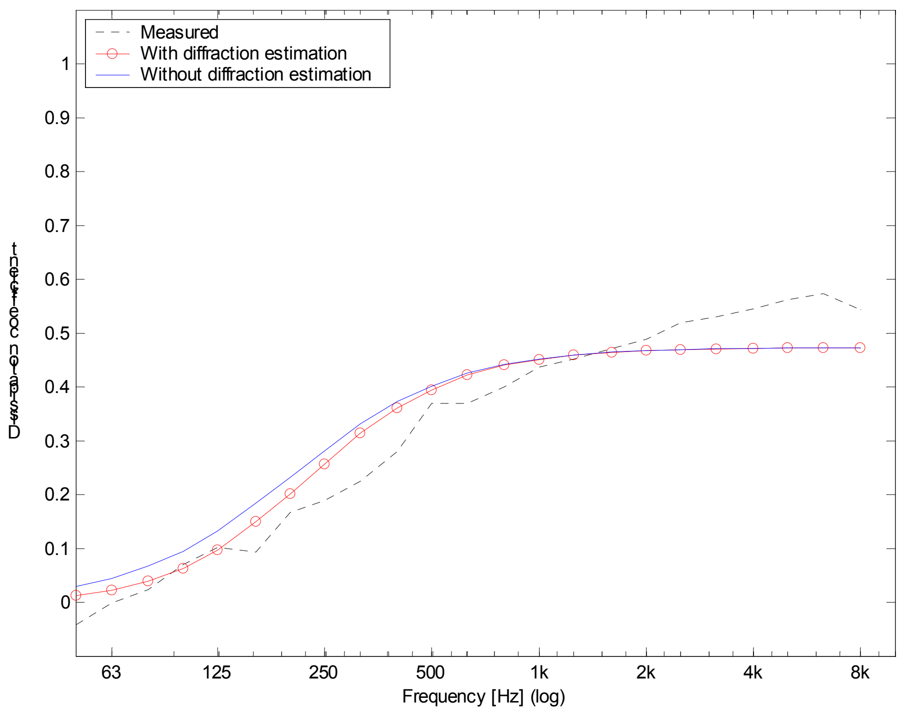

Figure 8: The dissipation coefficient for Velour with mass-correction.

In addition to the correction of mass, we may assume that the diffracted sound waves may hit the backside of the textile. This results in a higher, or in some cases lower, dissipation coefficient for the textile. The addition or subtraction may be expressed as:

$$C_H = \log\left(\frac{L}{K_1 \cdot \lambda}\right) \cdot \frac{H_0}{K_2 H} \tag{2.3-3}$$

where H_0 is 1 m, $K_1 = 8$ as with (2.3-1) and K_2 is also found with an iteration process. $K_2 = 2.5$ seems to fit well.

The corrected dissipation coefficient is then expressed by:

$$\rho' = \rho \cdot (1 + C_H) \tag{2.3-4}$$

The basis for (2.3-3) and (2.3-4) is that high frequency sound waves will bend more around the edges, and therefore hit more of the backside of the textile resulting in higher dissipation coefficients. Low frequency sound waves will only "pass" the textile resulting in lower dissipation coefficients.

The effect of this correction is seen in Figure 9.

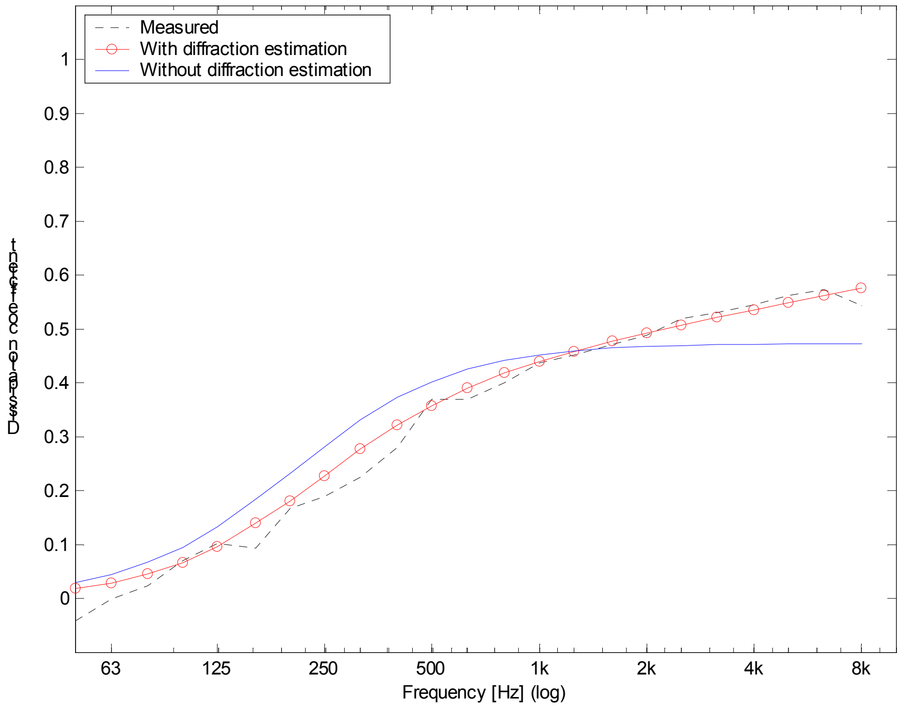

Figure 9: The dissipation coefficient for Velour dissipation-correction.

These two methods of correction may be regarded as semi-empirical. In (2.3-1) the height (*H*) is multiplied with 8 to move the reduction to the desired frequency range. The same adjustment is done with (2.3-3). These coefficients are based on calculations for all the seven textiles and the *K*-values that gave the best results where chosen. The reason why these adjustments are needed may be because the expressions have to account for different sound incidences and the assumptions stated earlier may be wrong.

It must be emphasized that this is a generalization based on the measured coefficient for only seven banners, and for only one size per banner. For example, for Scene Molton the measured values are reduced for frequencies above ca. 4 kHz. This is a situation not accounted for in these expressions. Very oblong textiles (for example length of 20 m and width of 0.5 or 1 m) the edge-effect may be over-predicted for higher frequencies. To predict the effect of diffraction more precisely, more textiles with different areas should be measured.

The formulas presented in this section are developed based on observation of the measured values in combination with differences in phase between the two sides. They should therefore be used with a critical eye and only as a (very) rough guide on the absorptive properties of a free hanging textile in a reverberation chamber. A new and hopefully better method of calculating the diffraction based on Huygens principle may be developed.

3 Absorption in Odeon

The results from the models described here may be used as input in Odeon. Therefore the dissipation and transmission coefficients for the seven textiles were calculated in AbsTex (see Section 4). The transparency was (as before) set to the squared average transmission coefficient for the 500 Hz and 1000 Hz octave band. For the absorption coefficients in Odeon, the dissipation coefficients from AbsTex (calculated with edge effect estimation as described in Section 2.3.3) were used. The MFT model is used and the scatter coefficient in Odeon was set to 0.7 for all textiles. See Figure 10 for results.

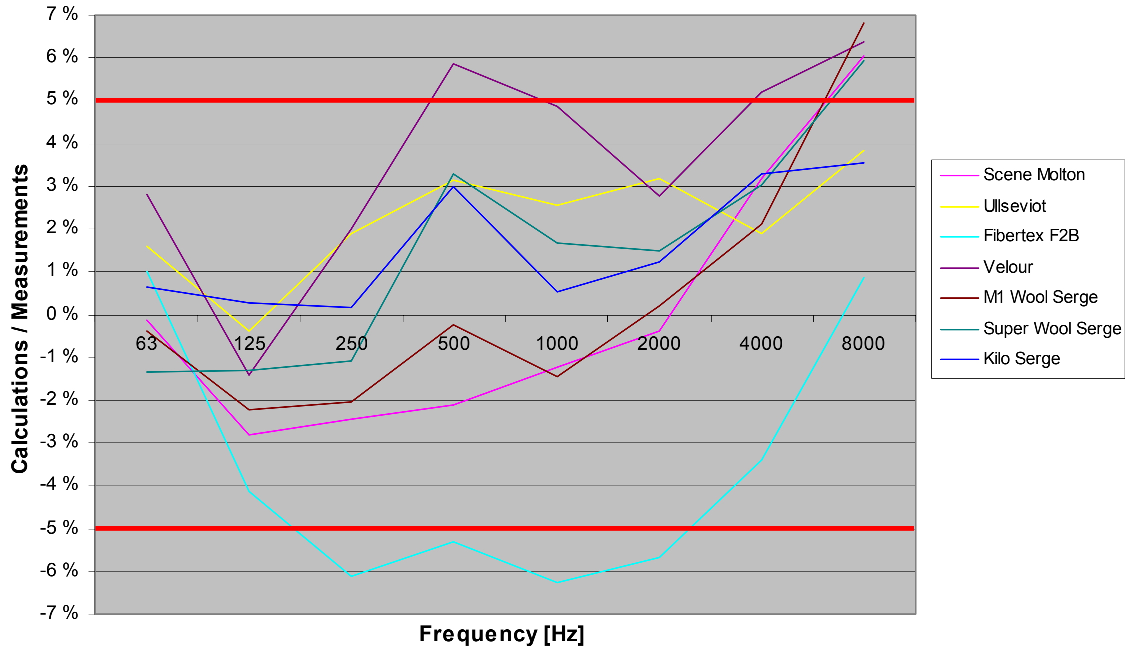

Figure 10: Relative errors of reverberation times for calculated textiles with edge-effect. Calculated dissipation coefficient is used, transparency is set to τ^2 (= $|T|^4$). Both mass-correction and dissipation-correction for the edge effect is used. The red line indicates the upper 5% range.

The calculated values for Fibertex F2B are lower than the measure values. This is not surprising considering the results the MFT model gives for this textile. If the edge effect is taken into account, the calculated dissipation coefficients for Velour gives the best fit to the measured absorption. Despite of this, Velour gives the second worst results when the calculated values are used in Odeon. The 5% limit is broken for 8000 Hz by Scene Molton, Velour, M1 Wool Serge and Super Wool Serge. But overall these results may be judged as acceptable since the all banners are between ± 7% of the measured data.

If Odeon is calculating the edge effect for high frequencies, disregarding the edge-effect from the input absorption will result in higher calculated reverberation time for these frequencies. See Figure 11 for results.

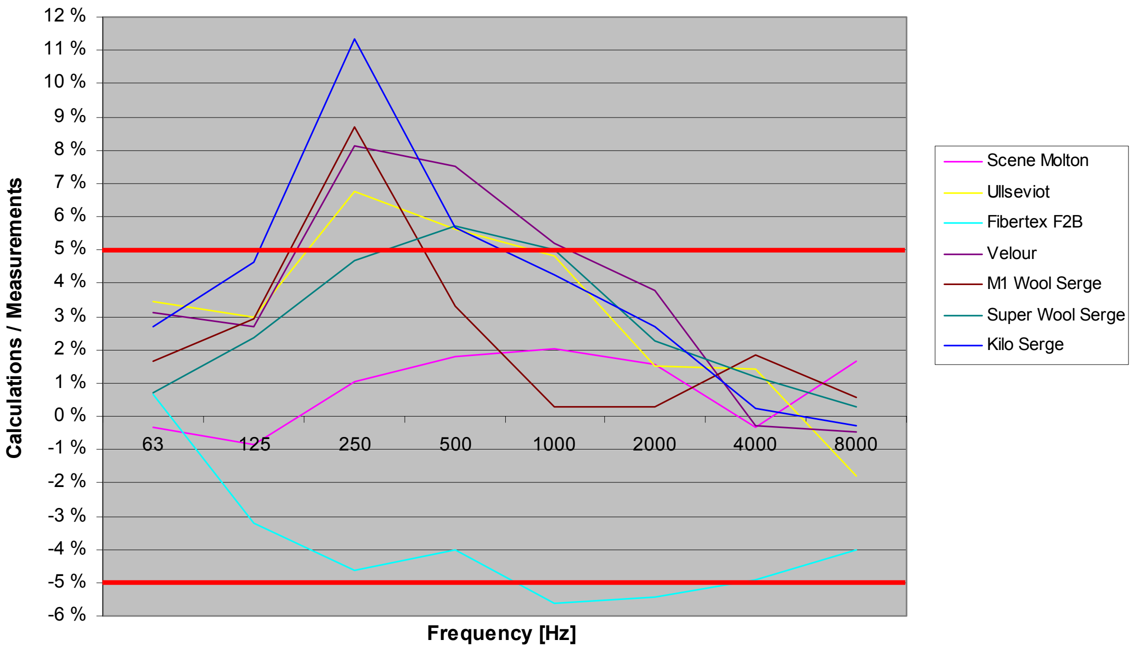

Figure 11: Relative errors of reverberation times for calculated textiles without edge-effect. Calculated dissipation coefficient is used, transparency is set to τ^2 (= $|T|^4$). The red line indicates the upper 5% range.

The results for 4 kHz and 8 kHz are better, but another deviation emerged between 250 Hz and 1000 Hz. All textiles except Scene Molton and Fibertex F2B broke the 5% limit in this frequency-range. The results for Fibertex F2B are a little better, but that may be because the edge-effect calculations aren't effective for this textile. The results for Scene Molton are rather good. This gave averagely worse results than using the edge-effect calculations.

4 AbsTex – A short user manual

4.1 The GUI

The right of the screen gives the user direct access to the most commonly changed settings. The calculated data is plotted in the right side of the screen.

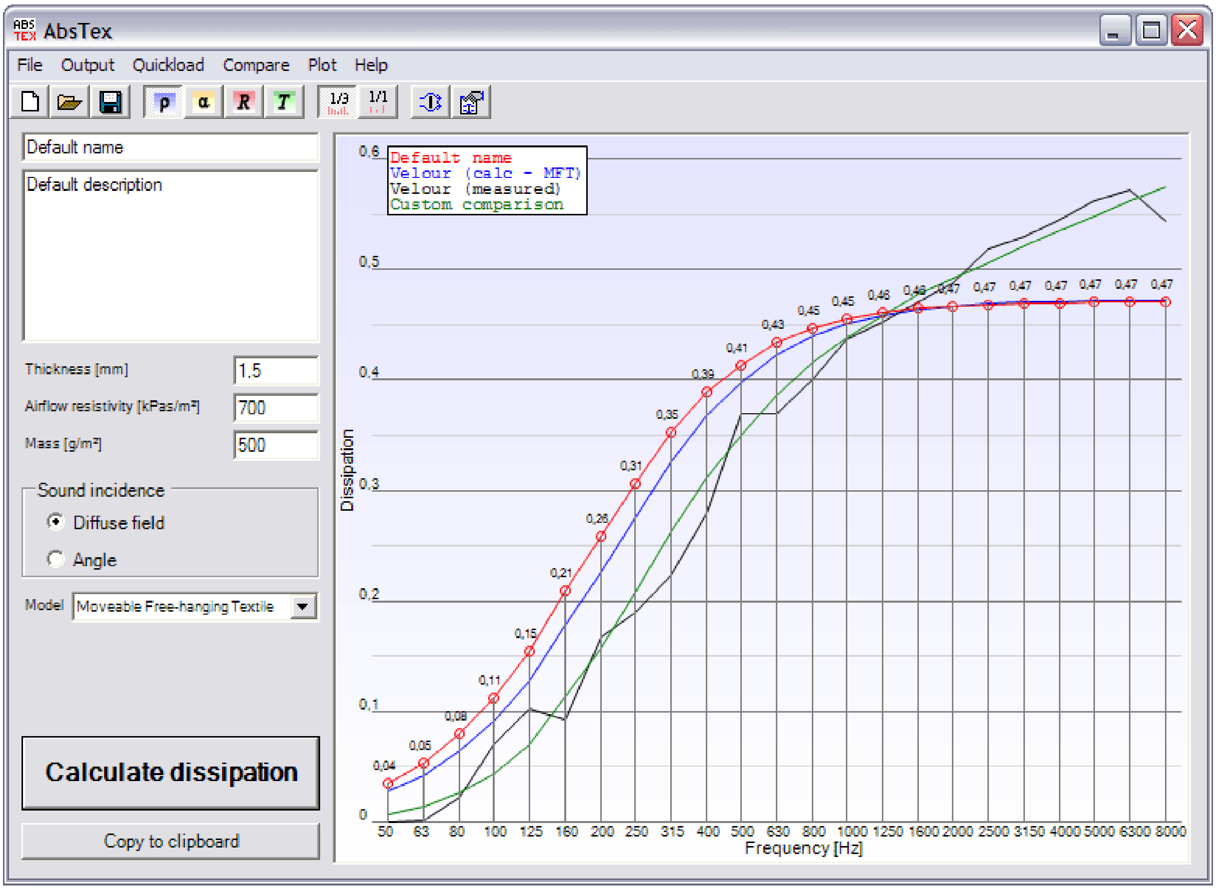

Figure 12: The AbsTex user interface.

The two first textboxes are for naming and describing the material currently being modelled for later reference. If the user selects *Angle* as *Sound incidence*, a new textbox will appear letting the user select the angle in degrees.

If the user right-click in the plotting area, the user has the option to turn the legend on and off, turn the background on and off and set the maximum value for the plot. See Section 4.2 under "The Plot menu".

If the user selects either the Modified Rayleigh or Modified Delany-Bazley model, a new textbox will appear under the *Model* dropdown-box that let the user set the porosity for the textile. If the user wants the program to choose the porosity, clicking the Suggest button can do this.

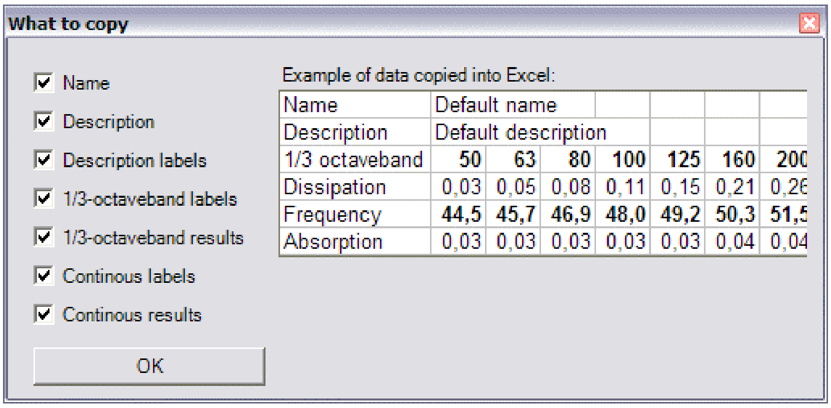

Figure 13: Options for copying data.

The *Copy to clipboard* button opens a new window, see Figure 13. Here the user can select the data he wants to copy/export to for example Microsoft Excel. The data is copied to the Windows Clipboard in tabulated format, which is directly supported by Microsoft Excel or Notepad.

Commonly used operations and options are also available from the Toolbar.

4.2 The menus

The File menu

Selecting *New* will open a new instance of AbsTex. Settings for the textile (mass, airflow resistivity, porosity, etc), the name and description may be saved to a textfile for later usage or distribution to others (using the *Open* and *Save* options). This text file is editable in for example Notepad. The lines in the textfile are:

1. Name
2. Description
3. Thickness in mm
4. Airflow resistivity in kPa·s/m^2
5. Mass in g/m^2
6. Incident angle in degrees
7. Porosity
8. Width of the banner in m
9. Height of the banner in m

The user may *Export* the results and model-information to a text file or to a Microsoft Excel file (if MS Excel is installed on the system). The *Generate report* option will export the textile-data, results and graphs to a Word-document (if MS Word is installed on the system). However, on some rare cases MS Word is not allowed to be started by other programs so Word may need to be started by the user.

The plot may be exported to a file in PNG, JPEG, GIF or TIFF format. JPEG is not recommended due to its high compression of information and thus loss in quality, and should only be used if the target application only can handle .jpg-files. The image will be exported with dimensions of 552·414 pixels.

The Output menu
The program can calculate the *Dissipation*, *Absorption*, *Reflection* and the *Transmission* coefficient and display the results in either *1/1 octave bands* and *1/3 octave bands*.

The edge-effect may also be calculated as described in Section 2.3.3. To calculate the dissipation with the influence of diffraction, select *Edge-effect* and *On*. If the user selects *Edge-effect → Set parameters* a new dialog box will appear (see Figure 14) letting the user set the width and height of the textile in metres. The user may then turn the edge-effect calculation on or off. If a banner is loaded from file or quickloaded, AbsTex will automatically set the width and height to the dimensions for this banner. Keyboard shortcuts are also available: Ctrl + E will turn the edge-estimation on and Ctrl + R will turn it off.

Note that the edge-effect is only estimated for the dissipation coefficient.

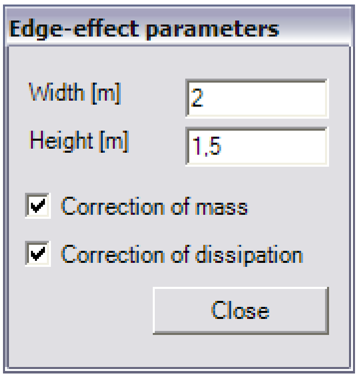

Figure 14: Parameters for edge-effect estimation.

The Quickload menu
The data for the measured banners might be quickloaded from this menu. The dimensions from Table 2 and the airflow resistivity and mass from Table 3 are used. Shortcuts are available: For example will the key-combination Alt + 1 quickload the data for Scene Molton.

The Compare menu

If the user chooses one of the seven banners for comparison the program displays the calculated dissipation coefficient (in blue) and measured absorption coefficient (in black). The calculated dissipation effect is calculated by the MFT model with weights as given by the manufacturers (Table 1) and the measured airflow resistivity (Table 3).

The comparison for the measured banners (1-7) is only available when the output is set to *Dissipation* in *1/3 octave bands*. For other comparisons, use the *Custom comparison* option.

Custom comparison displays a new window that lets the user paste data from for example Microsoft Excel for comparison. The data has to be tab-delimited in 1/3 or 1/1 octave bands (dependent of the choice in the Output menu). Set the cursor on the textbox in the upper left corner and press Ctrl + V (or right-click and select Paste). Press the *Transfer to memory* button. If the import was successful, the form should look something like Figure 16. Then press the *Close* button. If *Current calculation* is selected the data from the last calculation is used.

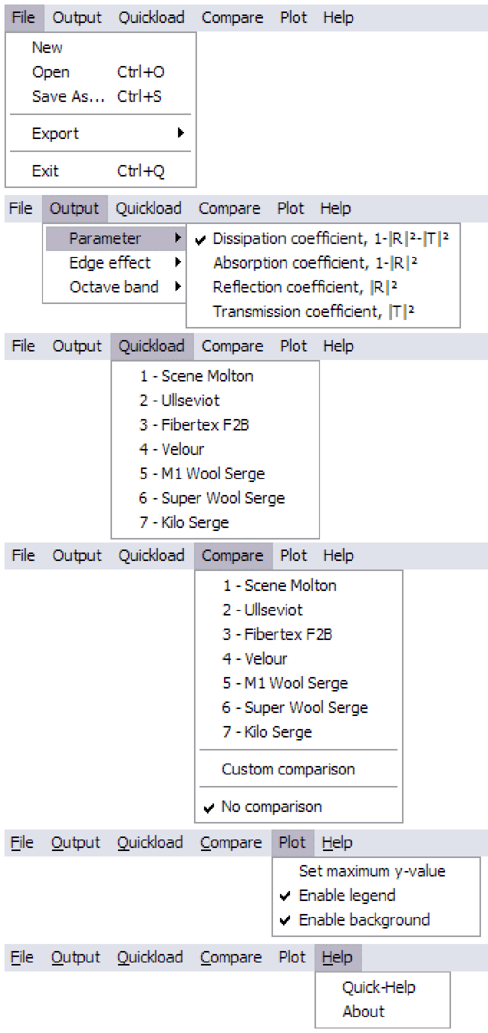

Figure 15: The menu structure.

The comparison might also be turned off. It will automatically be turned off if the users change output or the octave band setting.

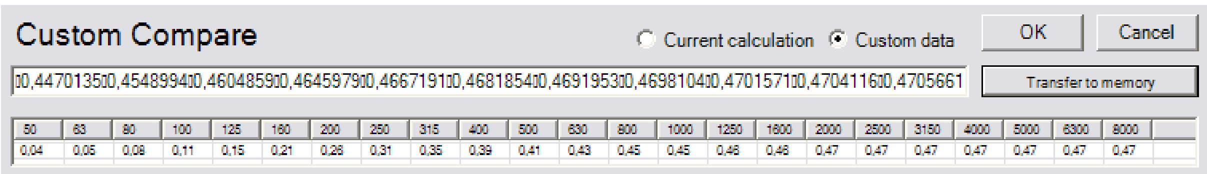

Figure 16: Custom compare with data from e.g. MS Excel.

The Plot menu

These options are also found when right-clicking in the plot-area. The maximum value for the plot is default set to 0.7. Values lower than 0.1 or higher than 1 are not allowed.

The Help button

QuickHelp displays a short guide to the program. *About* displays version number and contact information.

4.3 Frequently asked questions

Question: Is it possible to hold the current values in the plot?
Answer: Yes, the *Custom Comparison* function can do this. Just go to the *Comparison*-menu and select *Custom Comparison*. Click the OK-button, and the current calculation will be set as the Custom Comparison. If you want to update it quickly, this is possible with a series of quick key-combinations. Alt+C, C and Enter will turn Custom Comparison. Alternatively, you can start several instances of AbsTex.

Question: Why do I not see the entire graph when choosing *Absorption coefficient* or *Transmission coefficient* under Output?
Answer: The maximum y-value of the plot is set to 0.7 by default. Some of the calculated coefficients for these settings are usually higher than 0.7, and you may need to set it to 1.0. This is done with the *Set maximum y-value* in the *Plot*-menu.

Question: How can I calculate input data for use in programs such as Odeon?
Answer: The following procedure is recommended: Switch from *1/3 octave band* to *1/1 octave band*. Turn on the *edge-effect* estimation. Calculate the dissipation and transmission coefficients using the MFT model and copy or export them to for example MS Excel. Then use the dissipation coefficient as absorption in Odeon and set the transmission to the squared average of the transmission coefficient for the 500 Hz and 1000 Hz octave band (in Excel this is calculated as `=AVERAGE(D5:E5)^2` if the transmission coefficient values for 500 Hz and 1000 Hz are placed in cell D5 and E5). The scatter coefficient should be set to 0.7.

Question: May I request a new feature in AbsTex?
Answer: Yes, please do! Send an e-mail to magnus@ognedal.com and explain your idea. If your idea is good and/or there is a demand for this feature, the feature will be incorporated in a new version of AbsTex.

Question: I think I've found a bug. What should I do?
Answer: Please e-mail the error message (if any) and details of your operating system, computer and settings in AbsTex to magnus@ognedal.com.

4.4 System requirements, installation and upgrading

AbsTex will run on IBM-compatible computers using Windows 98, ME, NT, 2000 or XP as long as .NET Framework 1.1 is installed. Computers using Windows XP with Service Pack 2 is likely to have this installed. The Framework can be found on the internet [4].

The computer will run on virtually any computer, but the higher system specifications the better performance. AbsTex will run on a computer with a Pentium 75 MHz processor and 32 MB RAM, but it's not recommended since calculations and drawing of the graphs is very slow. AbsTex was also tested on a laptop with a Pentium II 300 MHz processor and 64 MB RAM, and it performed well (although the plot used some time to be drawn).

The installation is started by double-clicking on "AbsTex_Setup.exe" found in the AbsTex-directory on the CD (or using the "Install AbsTex" option on the CDs autorun-program). The setup-program will search for the .NET Framework on your computer. If you receive a message asking if you want to install the .NET Framework 1.1 click the "Yes"-button. After the installation of the Framework is completed, or if you already have the Framework installed, the setup program will install AbsTex.

The AbsTex homepage is found here: software.ognedal.com/abstex

The version of AbsTex available on homepage requires that the user sends an e-mail to magnus@ognedal.com with his/hers name. An unlock key will then be returned to you. This is done to get an overview of the users of the program. Registering is currently free. The unlock key will be necessary in order to unlock the full potential of AbsTex. The following limits apply until the user enters his/hers name and unlock key:

- The program will use ca. 30 seconds to start.
- Exporting disabled.
- Copying results to memory is disabled.
- Values are not shown in plot, only the graphs are shown.

5 References

[1] Ognedal M. (2004) *Sound absorption in textiles*

[2] Buen A. (2004) *Absorption in free hanging banners*

[3] Ingard K.U. (1994) *Notes on Sound Absorption Technology*

[4] Microsoft (2004) *.NET Framework Version 1.1 Redistributable Package*
http://www.microsoft.com/downloads/details.aspx?FamilyID=262d25e3-f589-4842-8157-034d1e7cf3a3&DisplayLang=en
(last visited 24.05.2005 16:15)

6 Contact information

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E-mail: magnus@ognedal.com

PS! This is only a fraction of the total document. If you want to learn more, please contact me. ☺